

# A PREDACEOUS AND SUPPOSEDLY BENEFICIAL MITE, PEDICULOIDES, BECOMES NOXIOUS TO MAN.

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## INTRODUCTION.

Attacks of mites upon humans are by no means new, various instances of this character having been observed in Europe and recorded in various English and Continental publications both entomological and medical. In this country, up to very recently, except in the case of the itch mite, *Sarcoptides psoriques* Megn., these have all been grouped under the name "chigger," which is evidently a corruption of "chigoe," a tropical species, *Sarcopsylla penetrans* L., which is not a mite at all, but a flea. Thus it has come about that people walking during summer in grassy or weedy places or in woodlands are very often attacked by "chiggers" and suffer serious inconvenience and much pain on account of attacks of what are probably the larvae of several species of mites; notably the Trombidiums, just which one or how many is not at present known.

The mite involved in the two epidemics of dermatitis in the United States, to which this paper especially relates, is quite certainly the same as the one discovered by myself in 1882 and determined for me by Mons. Jules Lichtenstein of Montpellier, France, as *Heteropus ventricosus*, Plate III, figs. 1, 3, and since known in this country as *Pediculoides ventricosus* Newport. Huber has since made this species a synonym of *Pediculoides tritici* Lagreze-Fossat, to which Moniez credits a large number of instances of mites attacking man in Europe.

## MITES ATTACKING MAN IN EUROPE AND OTHER COUNTRIES.

In a publication relating to parasitology, both animal and vegetable, by R. Moniez,<sup>1</sup> quite a number of recorded instances have been brought together, some of them it is quite probable, involving the species to which this paper relates. Moniez is, however, vague and indefinite, and while crediting a large number of attacks of mites upon man to *Pediculoides tritici*, the fol-

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1. Traite de Parasitologi Animale et Vegetal, Applique a la Medicine, Paris, 1896.

lowing statements made by him will most assuredly not apply to our American species, *P. ventricosus*, and if these food habits exist in *P. tritici*, this fact alone would separate the two species. On page 463 Moniez makes these statements:

"It appears certain that the octopod nymphs can only undergo evolution if they have at their disposition a liquid nourishment: they must attach themselves either upon some vegetable, or, in default of this, on some animal. In the case of wheat, they develop upon the larvae of insects that live at the expense of the grain. When the nymphs are famished, they will throw themselves upon workmen carrying wheat and attack the skin.

"Amerling, in Bohemia, did not find the mites in company with parasitic insects; they can live on the grain.

"When the cereals become dry, the mites attack animal life. They are forced to quit the vegetable kingdom for the animal. In this respect they act as do the Ixodes."

From the foregoing one is led to suspect that the obscurities surrounding the identity of man-attacking mites is scarcely less dense in Europe than it is in this country.

According to the observations of Lagreze<sup>2</sup> in 1849, in Espalais, France, a number of men engaged in carrying sacks of wheat experienced violent itching immediately thereafter. This wheat was sent to Bordeaux and Moissac where workmen in unloading the cargo were attacked in apparently the same manner. In the latter instance the men refused to work on account of the severe itching which immediately developed on the chest, arms, face and shoulders. In the case of a majority of the workmen this irritation of the skin was followed by an eruption of pimples more or less inflamed, some of which contained a serum. Later, experts who examined this grain reported the presence of numerous mites in the wheat and after this had been washed and dried in the sun, the workmen who handled it were not affected. The mite involved in this trouble is now known as *Pediculoides tritici*.

In 1867, Robin<sup>3</sup>, in the name of M. Rouyer, communicated to the Society of Biology some observations on a cutaneous disease observed epidemically in a large number of communities of the department l'Indre. The peasants engaged in gathering the

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2. (Lagreze Fossat et Montane, "Sur, la Mite du Ble." Rec. Agronomique de la So. de sciences agric. et belles-lettres de Tarnet-Garome, t. XXXII, 1851).

3. Robin, C. R. des seances et memoires de la Soc. de biologie, 4th series, t. IV, 1867, page 178.)

wheat after the long rains of summer, developed an itching eruption on all exposed parts of the body.

May 1, 1872, a baker in the canton of Créon received a number of sacks of wheat from Bordeaux. Five men who were engaged in carrying these sacks promptly developed severe itching on the back, shoulders and arms, followed by an eruption of somewhat pointed red pimples. Fear seized the patients and their families, who thought themselves poisoned, but experts examining this wheat determined the cause of the trouble to be what is now known as *Pediculoides tritici*. The condition caused by this mite has been given the name of "grain fever."

In 1875, Targioni-Tozzetti<sup>4</sup> reported an eruption produced in a laborer who had carried sacks of wheat.

In 1879, Geber<sup>5</sup> observed in Lower Hungary an eruptive epidemic coming from barley. It appears that in the first days of the month of June, barley which was shipped from Lower Hungary, in sacks, was being unloaded at a railway station. After being engaged in this work for a few minutes, these laborers were attacked by a violent itching and burning and to such a degree did this become annoying and painful that it was with great difficulty that they were induced to continue their work. Geber desiring to obtain farther information, visited the railway station in question about ten days after and examined the laborers who had been attacked.

In order to carry out an experiment of his own, Geber employed an idiot to carry a sack of barley precisely as the laborers had done. The idiot also began unconsciously to scratch and immediately an eruption somewhat like nettle rash attacked him. It was observed at the time the laborers were handling these sacks of barley a yellowish-brown powder of considerable quantity fell out of the sacks and this circumstance turned the attention of the officials to the barley. Upon a small part of this powder being brought under a microscope the presence of both living and dead mites was revealed.

The illustrations of Geber's paper are two figures, figure 2 representing with reasonable accuracy what might have been a

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4. Targioni-Tozzetti, Relazione intorno ai lavori della Stazione di Entomologie agraria di Firenze per l'anno, 1876, Annali, dell Agricoltura, t. I, 1878.

5. Geber, Entzündliche Prozesse der Haut, durch eine bis jetzt. nicht bestimmte Milbe Varursacht; Wiener Med. Presse, Vol. 20, 1879, et V. Ziemsen's Handbunchd, spec. Pathol. u Therapie, t. XIV, Handbuch, d. Hautkrank, 2, 1884, page 412.

female of *Pediculoides ventricosus*, at a stage of her development when these mites are most abundant in grain and straw, that is to say they had not yet commenced to become gravid. After making drawings of the ventral surface, Geber instead of turning this same individual over and making a drawing of the reverse or dorsal side took for this purpose what he presumed to be another mite of the same species. The facts are that in all probability the second mite was a male, as in speaking of the striking agreement between the two individuals, he says "it remains to be noted only that the individuals shown by figure 2 were very rare, only here and there were they to be found and they were easily recognized by their peculiar form." In view of this it would seem quite probable that the mite involved in the eruption recorded by him might have been what we in America know as *Pediculoides ventricosus*.

In July 1882, Koller<sup>6</sup> records a case where 36 workmen in Budapest were engaged in unloading sacks of barley coming from Roumania and were seized within a half hour by an intense itching, increasing in intensity during the several succeeding days. Vesicles, the largest of which were the size of a millet seed, appeared on inflamed bases on the neck, chest and other portions of the bodies of these laborers. Koller states in this connection that several years previously he had observed a similar malady contracted after unloading sacks of wheat from a boat.

Prof. Howath found a mite in the wheat which completely resembled that described by Robin, and several years prior to this, similar observations had been made on the banks of the Theiss, and in this case there was no other way to avoid the trouble except to submerge the boat with its cargo. At the same time that Koller observed this case, trouble was observed at Cologne with wheat coming from Russia.

Flemming<sup>7</sup> in 1884 published the results of similar observations upon workmen in Klausenburg, who unloaded wheat imported from Russia and were suddenly seized with a skin eruption.

If we compare these records from different parts of Europe and involving other adjacent countries as well, we will notice the similarity between these epidemics of a dermatitis and those

6. Koller, G. Ein Getreide-Milbe als Krankheitserregerin. Analysed in Biolog. Centrallbl. t. III, 1884, page 127.

7. Flemming, J. Ueber eine Geschlechtsreife Form der ala Tarsenemus beschriebenen Thiere, Zeitschr. f. Naturwissensch B. LVII, 1884, page 472, pl. 2.



occurring in America as recorded in the following pages. It would however, be too much to say that in all of these cases *Pediculoides ventricosus* was the species involved; but in view of the fact that the Angoumois grain moth, *Sitotroga cerealella*, Plate III, fig. 2, frequently becomes even more of a grain pest in those countries than it does here in America, one cannot but suspect that either the same or a closely allied species of mite is responsible for these attacks upon man. Mr. W. D. Hunter tells me that in Mexico he was warned not to allow the mites to get upon the hands of himself or his associates in his attempts to artificially introduce them into cotton fields attacked by the weevil, thus showing that its effect on man was not unknown there. Quite recently the writer has been informed that precisely similar effects have been experienced in New York City by men in handling peas from Italy, infested by *Bruchus* larvae, on which *Pediculoides* were observed to be parasitic.

*Pediculoides ventricosus* was described in 1853, and *P. tritici* Lag.-Fos was described in 1851. Huber<sup>8</sup> has made the former species a synonym of the latter, which, if sustained would throw nearly or quite all of the epidemics of dermatitis recorded to the credit of the one species and this would be known as *Pediculoides tritici* Lagreze-Fossat.

In *Zur Morphologie und Ontogenie der Acariden*<sup>9</sup>, Dr. Enzo Reuter cites *P. ventricosus* as a good species but makes no mention of *P. tritici*.

#### THE MITE BENEFICIAL IN AMERICA.

So far as I have been able to determine, the first published record of the occurrence of this mite in America was by myself, and was included in a paper printed in the Twelfth Report of the State Entomologist of Illinois, for the year 1882, pages 150-151. While assistant to State Entomologist Dr. S. A. Forbes, I was directed to investigate serious injuries to stored grain by the Angoumois grain moth (*Sitotroga cerealella*) in southern Illinois, where Messrs. Halliday Bros., of Cairo, extensive growers and shippers of wheat, were at that time experiencing considerable trouble from the ravages of this grain moth, not only in their grain elevators but also, in barges loaded with wheat to be shipped by river to New Orleans and thence exported by steamer.

8. Bibliographie der klinischen Entomologie (Hexapoden, Acaerinan.) von Med.-Rath Dr. J. Ch. Huber, Jena, 1899.

9. Acta Societatis Scientiarum Fennicae. Tom. XXXVI, No. 4, pp. 185 and 195, 1909.

It was while making these investigations, that this mite was discovered attacking the larvae of the grain moth. As the original publication containing my observations is becoming more and more difficult to obtain, that portion of my paper relating to the occurrence of this mite is given herewith in full.

*Pediculoides (Heteropus) ventricosus*, Newport. About the 12th of October, 1882, a sack of wheat infested with larvae of the grain moth was received from Southern Illinois, which, for want of time, was put aside for future inspection. On the 13th of November, while examining the grains containing larvae, I noticed in a lot of fifty, three in which the worms were dead, and on them were numbers of globular, yellow objects, which proved to be a species of mite *Pediculoides (Heteropus) ventricosus*, Newport. Knowing nothing of the predaceous habits of these mites, and the limited literature at hand throwing little light upon the matter, I did not pay much attention to the fact of their occurrence, until the 12th of December, when upon examining one hundred grains with respect to the effect of heat on the larva, I found fourteen of the latter infested by these mites.

In the meantime I had learned that this mite was known to be of predaceous habit, in both England and France, (having been first discovered by Newport, in 1849, in the nests of *Anthophora retusa*, collected at Gravesend, England,) and afterwards described by him under its present name. It had also been found in France, in 1868, by Jules Lichtenstein, of Montpellier, and described by him under the name of *Physogaster larvarum*. This gentleman found it in his breeding cages, which it so completely overran that, as he informs me, he could not for six months breed a single specimen of Hymenoptera, of Buprestidae, or Cerambycidae, or of some Lepidoptera. If it has been found by any other persons than these, or in any other parts of the world, previous to its discovery here by me, I have not been able to find the fact recorded.

On December 31st and January 1st, I examined one hundred infested grains of this wheat, which had been continually kept in the laboratory since it was received, and found thirty-two per cent. of the worms dead, infested by the mites.

While making these examinations I frequently threw the grains containing infested larvae into a shallow glass dish, where they remained on my table until the warm weather during the latter part of February, when the temperature of the laboratory at night was much higher than it had been during the previous cold weather. The effect of the change was soon plainly to be seen. The contents of the dish began to swarm with newly developed mites, and a larva dropped into their midst was immediately attacked, and after that its life was of short duration. Larvae placed at some distance from the dish suffered a like infection.

To test the matter I placed near the dish some weeds, in the pith of which some larvae were hibernating, and in two days the mites had found and destroyed them. These young mites when first noticed are

very minute, of elongate form, and extremely active, running about in search of larvae; and when one is found they immediately puncture the skin and suck the juices.

In a day or two the posterior segments of the abdomen begin to enlarge and this process continues until the inflated, bladder-like abdomen becomes ten or even twenty times the size of the cephalothorax. Plate III, Fig. 3.

During this time they have gradually lost their ambulatory powers, and remain stationary upon their victims. In the meantime changes equally wonderful have been going on within the abdomen.

Eggs are continually forming, and within these the young mites are as continually developing, passing through their entire metamorphosis, *which includes the acquisition of the fourth pair of legs*, (an exceptional character among mites) within the abdomen of the mother, from which they make their way as fast as they reach maturity.

The females are quite prolific. I have counted frequently from forty to fifty young and eggs within the abdomen, and believe that they produce even more. The mothers survive the birth of a large number, if not a majority of the young. The male I have never found, and I am inclined to believe with Mr. Newport, that the species is parthenogenous.<sup>10</sup> The minute size of those young mites admits of their free access to the larvae of the moth, through the very small opening where this made its entry, and a single mite with its progeny would be sufficient to destroy it.

That this is very often the manner of attack is proved by the fact that grains in which the larvae is badly infested frequently have no other break in the hull by which even a young mite could gain admission. Like the larvae on which they subsist, their development is retarded or increased by the temperature, they being quite active at a temperature of 60° Fah.; but in colder weather able to remain within the abdomen of the parent for months in a dormant state, awaiting a rising temperature.

While, as stated, this was probably the first published record of the occurrence of this *Pediculoides* in America, I have since had reason to believe that it was present many years prior to this date, and, indeed, in the light of information that has been obtained during the present year, 1909, it seems altogether probable that it not only occurred but became noxious to man, in Massachusetts, as early as 1830.

The particular reference, however, to which attention is called may be found in the "Prairie Farmer" for the year 1845, page 216. Much is here made of larvae attacking the stems of wheat above the upper joint and in connection therewith follows this significant sentence: "In one instance nine eggs were found in a

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10. I have since observed the male though only occasionally, as it is probable that each ♀ produces but one ♂ among her numerous progeny.

single straw, one of which had just hatched." Also, in another journal, we are told that specimens of infested straw were forwarded to the "Country Gentleman" from Scipioville, New York in 1870, which the sender stated contained eggs besides larvae and pupae. In both cases, the larvae were almost beyond a doubt those of *Meromyza americana*. According to my own observation, these mites attack the larvae of *Meromyza americana* in stems of wheat, and, when observed, one cannot fail to be struck with the clearness with which the statements just given describe larvae of this species in the stem of grain or grass being attacked by these mites, the gravid ♀ of which has every appearance to the unaided eye of being a minute egg. It therefore seems not improbable that this *Pediculoides* was abroad over the country at the earlier date, 1845, which would antedate by several years the description of the species by Newport in England; who called attention to the occurrence of this mite as a parasite in the nests of *Anthophora retusa*, in a paper read March 5, 1850, before the Linnean Society of London, and with the description published in the transactions of this Society, Volume XXI, 2, p. 95, 1853.

In the account given by Dr. T. W. Harris in the second edition of his "Insects Injurious to Vegetation" in connection with his discussion of the early occurrences of the barley Isosoma, *Isosoma hordei*, there are two very significant statements that have until lately puzzled me very greatly. On page 438, edition of 1852, he states that "in the summer of 1831, myriads of these flies (meaning the adult *Isosoma*) were found alive in straw beds in Gloucester; the straw having been taken from the fields the year before. An opinion at that time prevailed, that the troublesome humors, wherewith many persons were then afflicted, were occasioned by the bites of these flies; and it is stated that the straw beds of Lexington, being found to be infested with the same insects, were generally burnt." The second reference occurs on page 440 of the same volume, in which it is stated that "about eight years ago (which would be about 1844) some of these insects (again referring to *I. hordei*) that had come from a straw bed in Cambridge were shown to me. They had proven very troublesome to children sleeping on the bed; their bites or stings being followed by considerable inflammation and irritation, which lasted several days. So numerous were the insects that it was found necessary to empty the bed-tick and burn the straw."



Now, since first beginning the study of *Isosoma*, it has always been a puzzle to me, why it was that the adults of *Isosoma hordei*, as they were described by Dr. Harris, should have been able to bite through bed-ticking and cause the eruption described, and yet not be able to gnaw through this cloth and make their escape, as every one who has reared these insects in confinement has witnessed their frantic efforts to escape as soon as they gnaw their way out of the straw. It seems to me that, in this mite, now, we have as good an explanation as we can expect to secure, after a lapse of three-quarters of a century, with no possibility of obtaining actual proof in the case.

In 1884, I found this same mite attacking and destroying the larvae of *Isosoma grande* at Oxford, Indiana, and in speaking of the occurrence of this larva and its parasites, I made this statement: "Curiously enough, during the time it occupies the stubble in the larval and pupal stages, it sometimes falls a victim to the mite *Pediculoides* (*Heteropus*) *ventricosus*, which enters the stubble from above after the grain is cut, but whose sense of discrimination is rather poorly developed, and it is finally victorious over the *Isosoma* larvae, its parasites, and the predaceous larvae of *Leptotrachelus dorsalis*." The same year, and in the same locality, I again encountered this mite attacking the larvae of *Meromyza americana* in wheat straw, and again noted the remarkable resemblance of the gravid females to minute eggs. Since that time, this *Pediculoides* has been reported by Mr. E. H. Ehrhorn attacking the larvae of the peach twig borer, *Anarsia lineatella* Zeller, in California.<sup>11</sup> The same year Mr. Marlatt reports it as attacking the eggs of the periodical cicada *Cicada septemdecim*.<sup>12</sup> Still later, in 1904, Messrs. W. D. Hunter and W. E. Hinds in Bulletin No. 45, Division of Entomology, page 107, called attention to its attack on the larvae of the cotton boll weevil. In 1908, Mr. W. Dwight Pierce, in Bulletin No. 73, Bureau of Entomology, page 30, states that this mite is a common weevil parasite in Mexico. In the same publication, page 42, he accredits it to being parasitic not only on the cotton boll weevil, *Anthonomus grandis*, but also on an allied species, *A. eugenii*. Dr. A. D. Hopkins informs me that in his studies of forest insects, he has encountered it attacking the larvae of wood boring beetles and at

11. Bulletin No. 10, U. S. Dept. of Agriculture, Div. of Entomology, p. 17, 1898.

12. Bulletin No. 14, Div. of Entomology, n. s. p. 104.

one time, in West Virginia, it caused considerable mortality in his breeding cages, where he was attempting to rear wood-boring Cerambycidae and Scolytidae, precisely as experienced, in France, by M. Jules Lichtenstien.

Mr. W. J. Phillips observed this mite attacking the larvæ of *Mordellistina ustulata*, in Indiana, October 3, 1905, while investigating the occurrence of these larvae in the stems of timothy and other grasses.

In the publication of Messrs. Hunter and Hinds, previously referred to, some information is given relative to the attempt to use this mite artificially in overcoming the boll weevil. It has been experimented with quite extensively by Prof. A. L. Herrera and his assistants of the Mexican Commission of Parasitology, and upon his return from a trip to Mexico in the fall of 1902, Mr. Hunter brought with him, through the kindness of Prof. Herrera, a supply of the parasites, from which others were reared for experimental work in Texas. This experiment, however, owing to conditions beyond the control of man, perhaps happily so, appears not to have resulted satisfactorily. One of the principal obstacles in this case seems to have been that, where the mites succeeded in establishing themselves, they were subsequently destroyed by the attacks of small ants.

These references show quite clearly the wide distribution of this mite throughout the United States and its great variety of host insects. We have, in later years, come to consider it a very useful parasite and one that is likely to attack almost any soft-bodied larvae, beyond the reach of insecticides, but to which it, by reason of its minute size, could gain access and be secure from other predaceous insects and adverse meteorological conditions.

#### THE MITE BECOMES NOXIOUS TO MAN.

While, as stated in the earlier portion of this paper, either this or some other closely allied species has long been known to occasionally attack man and animals in Europe, when these are engaged in handling or come into contact with grain or straw infested by their host insects, the first instance of this character to be noted in America has been communicated to me by the present presiding officer of this Society, Dr. Henry Skinner, of Philadelphia, Pa. It was about the year, 1894 while Dr. Skinner was practicing medicine in Philadelphia, that the owner of a boarding house in one of the New Jersey suburbs of the city came

to him in great distress, stating that the tenant and keeper of the boarding house, which accommodated about seventy-five persons, would not pay the rent thereon, and further stated that the tenant had been threatened with legal proceedings by the boarders who had even suggested bodily injury. The cause of all of this trouble was an epidemic of a rash like disease, the causes of which were suspected to lie in the mattresses of the beds occupied by the patrons of the house, because of the occupants having been attacked by a very mysterious and aggravating skin eruption. The owner submitted straw dust and mattress debris taken from the suspected beds and on examination of this Dr. Skinner found specimens of this mite. The house was promptly deserted by the boarders, none of whom as it seems escaped infection and none of whom were willing to return. The matter does not appear to have been further investigated.

In the Philadelphia Medical Journal for July 6, 1901, Jay F. Schamberg, M. D., of Philadelphia, published a short paper, calling attention to and describing "An Epidemic of a Peculiar and Unfamiliar Disease of the Skin." In this paper, Dr. Schamberg, who, besides being a practicing physician, is professor of Dermatology, and Infectious Eruptive Diseases, in the Philadelphia Polyclinic, described a number of cases that had been treated by him a few weeks prior to the publication of this paper. The eruption and its effect on the patient were briefly described and illustrated, but the causes instrumental in bringing about these attacks were still unknown to him; and as several members of the same household were commonly affected the disease was considered likely to prove contagious. The dermatitis, however, was not lost sight of, and in a paper contributed to the Public Health Reports, Volume XXIV, No. 28, July 9, 1909, Dr. Joseph Goldberger, Past Assistant Surgeon of the United States Public Health and Marine Hospital Service, in cooperation with Dr. Schamberg, published the first exact information we have relative to the cause of these epidemics and this paper, so far as known to me, is the first publication in this country in which the attack of this mite has been followed up and its dermatological effect on humans carefully studied and described. This paper of Drs. Goldberger and Schamberg may be briefly summarized as follows:

In the spring and summer of 1909, this peculiar eruptive disease became quite prevalent in Philadelphia and neighboring

towns. An outbreak among 20 sailors upon a private yacht docked in the Delaware River attracted the attention of both the city and the Federal Health Authorities. The Surgeon-General of the U. S. Public Health and Marine Hospital Service delegated Dr. Joseph Goldberger, Passed Assistant Surgeon, to proceed to Philadelphia in order to make an investigation of the disease.

After examining the 20 sailors who had been sent to a hospital, Drs. Goldberger and Schamberg visited the yacht whence they came and made a searching examination of the conditions on board. Their attention was directed to the fact that a number of new straw mattresses had been received and that the disease was confined to those who had slept upon these mattresses or had placed their clothes upon them. Eleven officers and members of the crew who did not sleep upon the new mattresses remained entirely free of the disease.

At about the same period information was received concerning an eruptive disease prevailing among the sailors of four other boats, plying along the Delaware River. Investigation disclosed the fact that these boats had also received new straw mattresses, and, furthermore, that only those were attacked who slept upon the mattresses or otherwise came in contact with them.

In addition to these cases among sailors, Doctors Goldberger and Schamberg examined or received authentic information concerning 70 other cases of this disease occurring in twenty different households in Philadelphia and its vicinity. Plate IV.

In practically every instance they were enabled to determine that the patient had either recently slept upon a new straw mattress or had freely handled the same. Where only one person in a household was affected, it was found that he was the only one to occupy a bed supplied with a new straw mattress. They were able to trace all of the incriminated mattresses to four leading mattress manufacturers.

Careful investigation warranted them in excluding from consideration the ticking of the mattresses and the jute or cotton topping contained therein. The cause of the disease was, therefore, circumscribed to the straw. Repeated inquiries elicited the information that all of the manufacturers had received at the time the disease-producing mattresses were made up, wheat-straw from a dealer in Salem County, in southern New Jersey.



One manufacturer had used straw from this source exclusively in the affected mattresses.

*Finding of a Parasite.* Drs. Goldberger and Schamberg sifted the straw from a mattress through the meshes of a fine flour sieve upon a large plate glass covered with white paper. Close scrutiny of the siftings under strong electric illumination soon detected some slight motion. The moving particles were touched with a needle moistened in glycerine and transferred to a glass slide. Search with the microscope disclosed the presence of a mite of very minute dimensions. The mite was identified for them by Mr. Nathan Banks, expert in Acarina of the U. S. Bureau of Entomology, as very close to, if not identical with, the *Pediculoides ventricosus*.

In order to demonstrate experimentally the ethiological relationship of the suspected straw mattresses, Dr. Goldberger exposed his bared left arm and shoulder for one hour between two mattresses. At the end of about 16 hours, a number of characteristic lesions appeared upon the arm, shoulder and chest. Later three volunteers slept upon the mattresses and each one developed the eruption at the end of about the same period.

Dr. Goldberger later took some of the sifted straw, divided it into two portions and placed it in two clean Petri glass dishes. One of these was applied for one hour to the left axilla of a volunteer. At the end of from 16 to 17 hours, the characteristic eruption was present in the area of the left axilla to which the Petri dish of straw siftings had been applied.

The second portion of the straw siftings in a Petri dish was exposed to the vapor of chloroform under a bell jar with a view to killing any insect or acarine that might be present. These siftings were then applied to the right axilla of the same volunteer to whose left axilla the untreated siftings had been applied. The chloroform evidently destroyed in the siftings the agent that was producing the eruption for no lesions appeared after the application of the chloroformized siftings.

Dr. Goldberger further fished out of some straw siftings five minute mites, and, placing them in a clean watch crystal, applied the crystal to the axilla of another volunteer. At the end of about 16 hours following this application, five of the characteristic lesions appeared on the area to which the mites had been applied. Plate V, fig. 1.

INFLUENCES CONTROLLING THE EXCESSIVE ABUNDANCE  
OF PEDICULOIDES.

It will be noticed that Drs. Goldberger and Schamberg made no attempt to discover the underlying causes for the enormous numbers of these mites inhabiting the mattresses involved in their investigations, that problem belonging more properly within the realm of the entomologist. On my taking up this subject of the excessive abundance of the mites, Drs. Goldberger and Schamberg very kindly placed at my disposal everything in their possession relating to this epidemic, including the mattress which Dr. Goldberger had himself used in experiments carried out by him at the hygienic laboratory in Washington with this mite. Dr. Schamberg was equally kind in placing all of the material, notes and photographs in his possession, at my service.

Almost at the commencement of the investigation, Dr. Wm. Royal Stokes of the Maryland State Board of Health informed me that a similar but less extensive epidemic had shortly before been noted in Baltimore. This he kindly described as follows:

"The matter was brought to my attention by several persons who came to the Head of the Department and complained of the skin eruption described. They stated that a number of people in a suburban hotel were similarly affected, but I do not remember the number at this late date. These persons volunteered the information that they had all been sleeping on some new straw mattresses, and that all of the persons similarly affected had used these mattresses.

"I saw Dr. Gilchrist, the Clinical Professor of Dermatology at Johns Hopkins University, yesterday, and he gave me the following description of the one case which he saw at the Health Department. I saw two other cases which corresponded with these in a general way.

"The eruption consisted of about 1000 wheals, or erythematous-withicarial spots, or pauplo-withicarial lesions. As in the description in the reprint of Drs. Goldberger and Schamberg of the United States Public Health and Marine Hospital Service, they varied in size from a lentil seed to a finger nail, and are round, oval, or irregular in shape. No vesicles or pustules were seen. The eruption was on the neck, chest, abdomen, and back, and also on arms and legs. Itching was present, and all lesions showed evidences of scratching.' "

Besides this, there were several cases reported to me from northern Maryland, where farmers in running their wheat through a fanning mill had been simultaneously troubled by a very similar or identical eruptive disease of the skin. In another instance, a thresherman engaged in feeding the unthreshed grain into the cylinder of the threshing machine was also affected by a disease of the skin, with which the attending physician was unfamiliar and who could not classify it with any of the urticaroid dermatitis known to him. With my experience of previous years, it seemed impossible that this *Pediculoides* should become sufficiently abundant to cause this dermatitis without there being an excessive abundance of some host insect or insects affecting either the straw or the grain itself. Naturally, the studies made by me in 1882, led me to suspect that this grain moth *Sitotroga cerealella* might be responsible for the abundance of the mites. Then, too, the fact that it attacked the larvae of *Isosoma grande* in wheat straw, led me to suspect that, as this particular species is not known to occur in the vicinity of Philadelphia, while its near relative, the joint worm, *Isosoma tritici*, does occur more or less abundantly over the eastern part of the country, this latter species, too, might perhaps be involved.

With a view of finding out something of the abundance of the grain moth in New Jersey, from which State was obtained most but not all of the straw entering into the mattresses mentioned by Drs. Goldberger and Schamberg, I applied to Dr. John B. Smith, State Entomologist, for information. In reply Dr. Smith was kind enough to send me an advance copy of the report of his department of the New Jersey Agricultural Experiment Station for the year 1908, and from this publication it was learned that during the summer of that year, owing to favorable weather conditions, this moth developed rapidly in the field and there was great damage to wheat among those farmers who delayed threshing until September or later. Furthermore, a very large percentage of the wheat crop gathered that year became useless for milling purposes and so general was the infestation that grain from some localities was entirely barred at mills except when ground for the owner. Some further investigations carried on in eastern Pennsylvania revealed a very similar condition of affairs. It was the straw of 1908, coming mostly from New Jersey, but a small part of it from Indiana, that en-

tered into the mattresses, from the use of which came the epidemic in and about Philadelphia.

In order to settle these points, Mr. V. L. Wildermuth, an assistant in the Bureau of Entomology, in cereal and forage insect investigations, was instructed to examine the straw in the mattress placed at my disposal by Dr. Goldberger. After a day and a half of careful search, only five straws affected by the joint worm were found. This seemed to entirely eliminate this species from consideration in connection with this particular epidemic. There were, however, many wheat heads remaining attached to the straw and these heads contained a great many kernels, the contents of which had been eaten out by the larvae of the grain moth. Moreover, these eaten kernels contained great numbers of the dead bodies of *Pediculoides*. That *Sitotroga cerealella* was the cause of this damage to the wheat was still further proven by the emergence of an adult moth from these eaten kernels on November 15. The larvae of this moth infested the kernels of wheat before the latter were threshed. Many of these infested kernels remaining in the straw were included in the material going into the manufacture of these mattresses. The greater portion of the living larvae of the moth would develop to adults during May or early June, thus cutting off the food supply of these mites. The mites would therefore very naturally swarm among the straw and making their way through the cloth covering of these mattresses attack anything that gave promise of furnishing food, and preserving them from starvation. It seems that starvation is the final outcome, however, for, as already stated, no trouble is experienced in using the mattresses after a certain period, which period probably indicates the termination of the life of the mites infesting the straw. It therefore did not seem necessary to seek farther for the primary cause of this eastern epidemic of dermatitis, the center of which seems to have been in and about Philadelphia.

#### A WESTERN EPIDEMIC OF THE DERMATITIS.

While the problem of the epidemic in the east was apparently solved, some of the wheat straw involved therein had come from Indiana, and during the last few years an outbreak of the joint worm, *Isosoma tritici*, had been gathering force, throughout Ohio, Indiana and southern Illinois, until during the summer of 1908, very serious damages occurred. Investigation of the insect dur-



ing previous years had shown that the outbreak really began in the more elevated portions of Virginia, in the upper Shenandoah Valley, West Virginia and eastern Ohio, as early as 1904; afterwards advancing broadly to the westward.

During the summer of 1908, there came to the Bureau, from this section of the country, a great number of complaints of serious skin trouble among people engaged in threshing grain that had been stored for some time in barns; in some localities it having become difficult to secure help to thresh under such conditions. Also the same disorder was encountered by those who used this straw for the purpose of filling bed-ticks, or as a substitute for felting under carpets, and in one case, berry pickers had been attacked when such straw had been used as a mulch for berry plants. This straw came from one of the fields most seriously injured by joint worm attacks in 1908. In one instance, a car-load of wheat straw was shipped to Pittsburg, Pa., and six men engaged in unloading it, were all attacked by some skin eruption, and the horses used in hauling this straw after it was unloaded, also suffered from what was seemingly the same disorder. Perhaps the following from a correspondent of the Bureau of Entomology, residing in southern Ohio, will give a fair idea of the situation on many farms in that section of the country.

“ About four years ago a parasite was found when threshing wheat out of barns. They seem to affect the victims almost as soon as they get into the mow. The men began to scratch themselves generally on the neck and on the arms (inside) opposite the elbow, and on the body back and front. They raised welts as you describe and progress about as you describe. They have spread to such an extent that farm hands dread and fear them and will not change work with neighbors unless they thresh in the field. (They are found out of barns.) Here of late they are found in wheat straw in the barns, especially if baled. Last week a farmer brought me baled wheat straw that seemed to be alive with them. They attacked every one that went in the barn and one of my horses that was perspiring from effects of a drive was simply covered with little knots or swollen places and bit and rubbed himself continually. I had to have the straw hauled out and burned and barn disinfected. The farmer stated that they were so thick in the shed that contained the straw, that he had to keep all stock out of the shed.”

Many other similar letters from towns in Ohio were received by Dr. Schamberg, particularly from Zanesville, Columbus, Vincent, Springfield, etc., where the affection is popularly believed to be due to "chiggers." A physician from the last named town stated that in the fall of 1908, during harvest and threshing time he saw in Washington County some 87 cases of the disease in question. It affected the harvesters and threshers. This spring he observed 38 cases from contact with straw ticks refilled with straw of last fall's crop. The disease is said to have been more prevalent last year (1908) than ever before. Information has come from Columbus, Ohio, that potters who used straw for packing crockery ware have been so badly attacked at times that the entire force of packers has been off duty. Many times a whole car-load of straw has been so affected that the use of it has been abandoned. In Springfield, Ohio, it is said that the disease was so bad a year or two ago in the lowlands west of this city as seriously to hamper the progress of the construction of a large sewer. This, however, might have been due to attack by other mites, notably to *Trombidium* larvae. In Zanesville, Ohio, the potters have been obliged to abandon the use of straw and employ "prairie hay" for packing purposes.

Dr. Schamberg was also informed by a physician of Pittsburg that a young woman patient has suffered from an affection closely resembling, if not identical, with the one under consideration, each time that she has assisted in emptying cases of dishes packed in straw. Both the physician and the patient had come to believe that something in the straw was the cause of the eruption.

Indeed, so nearly did the territory from which these complaints came to us, coincide with that affected by the joint worm, that it created the suspicion, not only among those engaged in the investigations, but even among farmers themselves, that there must be some connection between the two phenomena. Very many of these cases were brought to the notice of practicing physicians, but they were themselves at a loss to account for the prevalence of this dermatitis, many of them supposing it to be some species of rash that was more or less contagious, the exact nature of which they did not know.

Among these physicians was Dr. Lyman T. Rawles, of Huntertown, Indiana, who in May, 1909, took up a careful study of a number of cases of this dermatitis that had come under his personal observation as well as those of some of his associates. Dr.

Rawles' investigations were very carefully made and the results are exceedingly valuable for the reason that, in case of this western epidemic, he was able to trace the cause of the dermatitis to *Pediculoides ventricosus* and follow this back to the host insect *Isosoma tritici*. This paper of Dr. Rawles<sup>13</sup>, of which a summary is given, not only clears up the obscurity with reference to the cause of this epidemic in the Middle West, a section throughout which the grain moth (*Sitotroga cerealella*) never occurs in excessive abundance excepting in grain that is kept in store, and then only in the more southern portions of Indiana and Illinois; but, furthermore, these studies seem to solve the problem of the cause of the skin eruption noted by Dr. Harris to have occurred as far back as 1830.

In May, 1909, Dr. Rawles found in his practice that a very strikingly strange skin disease presented itself in his and surrounding country in epidemic form. Through the press notes it seemed to be quite general over the northern part of the United States, limiting itself to the wheat growing sections.

The people generally affected were farmers and those living in small villages or towns where straw is used in beds, under carpets and around stables to bed stock. Horses and cattle have been seen with a skin disease almost identical to that seen in man. The following incident led him to an investigation as to the probable etiology:

A family had cleaned house, refilling the straw ticks of their beds and placed fresh straw under the carpets, and in about one week the family had developed this peculiar skin disease. In the beds were found a small, black fly, *Isosoma tritici* Fitch, about the size of an ordinary gnat, which at first it appeared to be, but closer observation revealed that it was not of the gnat family. Upon examination of the straw it was found that a large number of the straws were perforated; these perforations were through the wall in the region of the joint, generally about two inches from the joint. The perforations were about the size of a small pinhole and ranging in number from ten to thirty in a straw. Upon examining a section of this straw the *small black fly* was found *under many* of the openings through the walls.

Several flies were examined to ascertain if they possessed a piercing proboscis, and while observing one which has just been taken from under the sheath of the straw, through which there

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13. Journal of the Indiana State Medical Association, August, 1909.

was no perforation over the fly, a small mite was observed crawling over the dead body of the fly.

Placing the bodies of several of these flies under the microscope and using a  $\frac{1}{4}$ -inch objective and a No. 5 eye-piece, it was found that on nearly all flies over which the wall was intact, a small mite could be detected, these mites varying in number from two to four mites to each fly. Upon furthering the observations it was found that the dermatitis lasted after the flies had been observed and exterminated.

The following experiments were tried to prove whether it might be the fly or the mite that was the etiologic factor in producing the dermatitis.

Six live flies were taken, upon which no mites could be found; these were placed under a watch glass and bound upon the right arm, leaving them in contact with the skin for three hours. Upon the left arm four dead flies, on which living mites had been observed, were placed under a watch glass and left in contact with the skin for three hours, after which the glasses were removed and results awaited. The right arm showed nothing. Upon the left arm there appeared within twelve hours four small wheals, the character and evolution of which are later described.

To further the experiments some fresh lesions of patients were scraped and the scrapings examined microscopically and two of the mites were found in the scrapings.

Itching is the most prevalent and first symptom to attract the attention of the patient. It is most persistent and intense during the after part of the night. At about the time the itching was most intense there appeared an urticarial eruption, accompanied, in severe cases, with general systemic symptoms, such as rise of temperature from 99 to 102; in one case the temperature rose to 103.8; the pulse rate is accelerated to 100, or as high as 110—in one case to 130. Other symptoms were intense headache, anorexia, nausea, in some cases vomiting, and a mild form of diarrhoea. In severe cases some complained of general joint pains and backache; in these cases the urine was examined and albumin in small amount was found, but no casts or blood. When the acute symptoms disappeared so did the albumin.

Many patients who suffered from mild cases complained of nothing aside from the intense itching. If all straw was removed from the beds and house the symptoms would subside in one or two days and completely disappear in a few days more.



The lesion which is typical of the disease is the urticaria vesiculosa. The urticarial lesion varies in size from that of a split pea to that of a penny; it is surrounded by a pinkish halo, varying in intensity of color from a pale pink to a most bright pink. The "hive" like lesion is at first blanched, but later becomes a rose red color. It is elevated about 1 or 2 mm. above the skin surface, and is surmounted by a small vesicle containing a whitish fluid marking the place of inoculation. The vesicle is about 1 or 2 mm. in diameter and elevated about 3 mm. above the surface of the urticarial lesion. As the lesion grows old it goes through the process of evolution: (1) it is blanched and has a central vesicle; (2) it is rose red and the vesicle may become a pustule; (3) it generally recedes to the skin level with scab formation, due to the scratching; (4) it leaves a brownish or greenish-yellow or purple spot on the skin surface. In debilitated patients the markings look not unlike faded indelible pencil marks. (This was noted in a patient suffering from pulmonary tuberculosis.) These discolorations may last for several weeks.

The anatomical location of the lesions is generally the back, sides and abdomen, and less frequently the arms and legs. The neck has very few lesions; the face, hands and feet have very few or none.

The number of lesions depends upon the number of mites, ranging in number from very few to thousands; in some cases the back and abdomen have been almost a solid mass of lesions—new lesions on the tops of old lesions, so having lesions in all stages of development.

#### OBSCURITY SURROUNDING THE OCCURRENCE OF THE DERMATITIS.

The exact nature of this eruptive disease was not at all understood by the medical profession throughout the country. In South-western Virginia, threshermen suffered from the same disorder, but attributed it to "chiggers," and local physicians, though skeptical, were themselves unable to correctly diagnosis or to account for the trouble. As the disease is not serious and passes away in the course of time without leaving the patient in any way permanently injured, it seems to have been passed over by medical men without investigation excepting by the physicians whose publications have just been cited. Among the people themselves the eruption was probably more frequently attributed

to attacks of "chiggers" than to any other cause and it is quite likely that this common erroneous interpretation of the origin of the eruption has prevailed generally throughout the country, including the upper Shenandoah Valley in Virginia, where the joint worm was abundant as far back as 1904. It has been confused with small-pox and more frequently with chicken-pox. It, was, consequently, exceedingly unfortunate that, with the beginning of this disorder, an institution in one of the States involved, should publish an unsigned newspaper bulletin, crediting these epidemics of this eruption to the attack of "chiggers," and, furthermore, at the very time when Drs. Goldberger, Schamberg and Rawles, as well as the Bureau of Entomology, were exerting every effort to find out the true cause of the difficulty, that a second press bulletin, accentuating the first, should have been issued, and, sent to every newspaper in the State, and from those copied into other newspapers throughout the country. Thus it is that an entirely erroneous impression has been magnified and diffused, still continuing to prevail throughout the country.

In order to determine the likelihood of those handling straws in the wheat field, being attacked by the small red mites, often innocently mistaken for "chiggers," that abound among the harvested grain at this time, Mr. Wildermuth made a number of experiments to determine whether or not these mites, probably *Tydius* sp., were liable to attack men. In no case was he able to provoke an attack from them, even when they were confined upon the skin of his bare arm. On the other hand, examination of straws from various points in Ohio and Indiana have revealed the presence of *Pediculoides* in the cells occupied by the joint worm. This seems to entirely eliminate "chiggers" from these investigations, because these were probably not present, and there does not longer appear to be any doubt but what *Pediculoides ventricosus* is to be charged with causing these epidemics of this dermatitis, and the cause of its own excessive abundance lies in the outbreaks of the Angoumois grain moth among the grain itself in the East and the joint worm in the wheat straw in the Middle West.

#### LIGHT THROWN UPON OTHER PROBLEMS.

These investigations have illustrated very nicely the extent to which the solution of one entomological problem will at the same time also solve other problems more or less closely allied to

the original one. The light thrown upon the cases of eruption noted by Dr. Harris with reference to *Isosoma hordei* has already been explained. The present outbreak of the joint worm in the Ohio Valley probably originated in the upper Shenandoah Valley of Virginia, extending northward and westward throughout West Virginia and eastern Ohio. When investigation of the insect was taken up in 1904, a parasite, *Ditropinotus aureoviridis*, was also noted in excessive abundance, but for some reason it did not overcome the joint worm. This phenomenon has been noted continually. Since that time it has been a perpetual enigma to me why it was that with such an abundance of its natural enemies the joint worm should continue to spread and increase in destructiveness. Now, however, that we know that this predaceous mite is able to develop through a series of years in such immense numbers in connection with the joint worm, the matter comes nearer a solution. *Ditropinotus*, as well as some other parasitic enemies of the joint worm, emerge in early July from eggs that were previously placed in the cells occupied by the joint worm. As soon as these adult parasites emerge they at once oviposit in cells containing joint worm larvae of the same generation from which they themselves developed. The puncturing of these cells by the ovipositor of these parasites, particularly *Ditropinotus*, opens a way for the entrance of this microscopic mite, and, once inside of the cell, it will destroy everything therein, whether it be joint worm or parasite. Thus the predaceous mite has prevented the other parasites from exerting their full influence, because it has continually checked the increase of other parasites, thereby preventing them from increasing and exerting the restraining influence upon the joint worm that, but for this mite, they probably would have done.

In the light of the foregoing, it would appear that the only way to evade this disorder among humans, caused by this mite, lies the prevention of the occurrence of these two destructive grain insects which are responsible for the abundance of the mite itself. There is, therefore, a double incentive for the farmer to use every effort to prevent the occurrence of these pests in his fields. In many fields in Ohio we have found that more than one-half of the straws had been attacked by joint worm, and the damage resulting from their attacks amounted to a considerable percentage of the farmers wheat crop. See Plate V, fig. 2. If, in addition to this, his own family and employees are to suffer

annoyance from this dermatitis, and we know that the mite is present generally, also those who attempt to use mattresses into the construction of which the straws from these fields have entered and indeed in even handling the same, the results of his agricultural methods will be sent wherever, in the entire country, these mattresses, or the straw itself, go into practical use within at least a year from the time the wheat straw was harvested in the fields, and thus people hundreds of miles away, with no possible means of knowing of the presence of these mites in mattresses, are caused not only great aggravation but intense suffering through their use.

#### PREVENTIVE AND PROTECTIVE MEASURES.

From the foregoing, it will be observed that that public protection from this skin disorder is only to be secured through revised agricultural methods of the farmer, who, while offering this protection, will also materially increase the profits of his business. Throughout the territory involved in the eastern epidemic of this dermatitis, which, as has been shown, was due to the excessive abundance of the Angoumois grain moth, the evidence recently attained by the writer has been overwhelmingly to the effect that where wheat was threshed as promptly as possible after harvest and directly from the shocks in the field, almost no occurrence of this grain moth was observed by millers and others handling the threshed grain, and without which there would have been no mites. On the other hand, when drawn from the field and placed unthreshed in the barn, the damage from this pest has varied up to nearly fifty per cent., and has so affected the crop as to cause its rejection by millers, except where ground on the farmer's order. Here, then, lies the protection of people who use mattresses made of this wheat straw, grown in this section of the country, or otherwise come in contact with the same. Reiterating in a condensed statement: Wheat should be threshed immediately after harvest and directly from the field.

In Ohio, Indiana and Illinois, where the mite causing this dermatitis has increased enormously on account of the prevalence of the joint worm, see Plate V, fig. 3, wheat also placed in barn before threshing has been found to be much more dangerous to handle with reference to epidemics of this disorder. At the same time, the difference between wheat threshed in the field and in the barn is not so striking as where the primary trouble was in the abundance of the grain moth.

A careful study of a large number of wheat fields in central Ohio, has shown that the infestation from joint worm, the present



